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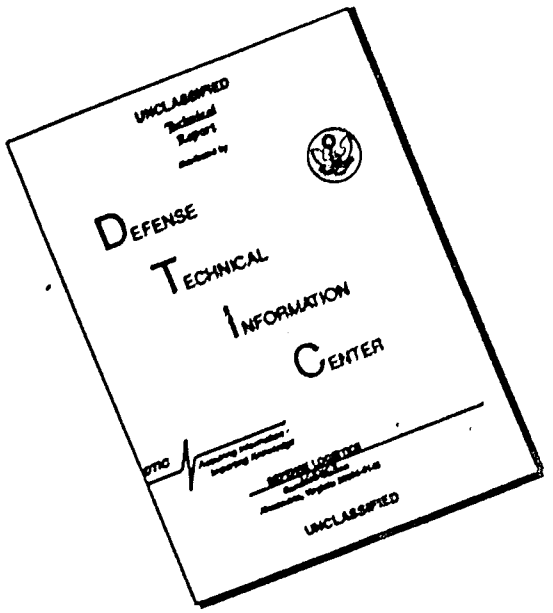

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TACTICAL WHEELED VEHICLE FLEET REQUIREMENTS

ACN 62072

FINAL REPORT

VOLUME I: EXECUTIVE SUMMARY - PHASE I

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UNITED STATES ARMY
TRAINING AND DOCTRINE COMMAND

TACTICAL WHEELED VEHICLE FLEET REQUIREMENTS

Volume I, EXECUTIVE SUMMARY, PHASE I

ACN 62072

FINAL REPORT

OCTOBER 1980

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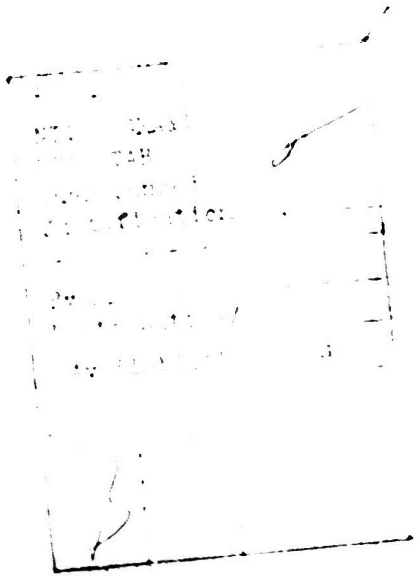
RE: Distribution Statement, Tactical Wheeled Vehicle Fleet Requirements, Vols. I, II, III USGO, T & E, Others to: U. S. Army Training and Doctrine Command, ATTN: ATCS-D, Fort Monroe, VA 23651 per Mrs. Barbara Cohen, TRADOC, ATTN: ATCS-D



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The conclusions and recommendations of the study are those of the Commandant of the Transportation School and are based on information gathered and analysis done by the Transportation School in coordination with TRADOC schools and agencies, with DCSOPS and DCSRDA and with DARCOM.

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ABSTRACT

This is a Department of Army directed study designed to answer the questions on tactical wheeled vehicle fleet composition and requirements as posed by the House Appropriations Committee of the United States Congress. The methodology used the automated procedures established throughout the Army for defining requirements and developing procurement programs. These procedures are applied to eight alternative vehicle fleets and the results are compared to a base case to establish the preferred alternative.

GLOSSARY OF ACRONYMS AND TERMS

AAO	- Authorized Acquisition Objective
ARMY 86	- An ongoing series of organizational and doctrinal studies including Division 86, Light Division 86, Corps 86, and echelons above corps.
AURS	- Automated Unit Reference Sheet
BOIP	- Basis of Issue Plan
CBS	- Continuing Balance Summary
CFV	- Cavalry Fighting Vehicle
COEA	- Cost/Operational Effectiveness Analysis
CTIS	- Central Tire Inflation System
CUCV	- Commercial Utility/Cargo Vehicle
DA	- Department of the Army
DARCOM	- Development and Readiness Command
FAS	- Force Accounting System
HEMTT	- Heavy Expanded Mobility Tactical Truck
HMMWV	- High Mobility Multipurpose Wheeled Vehicle
IFV	- Infantry Fighting Vehicle
IIQ	- Initial Issue Quantity
LIN	- Line Item Number
LOGSACS	- Logistics Structure and Composition System
MACRIT	- Manpower Authorization Criteria
MARS	- Materiel Acquisition Readiness System
MLRS	- Multiple Launch Rocket System
MTOE	- Modified Table of Organization and Equipment
NICP	- National Inventory Control Point
OS	- Operating and Support Cost

ORFF	- Operational Readiness Float Factor
PAYLOAD CATEGORY	- 1/4-Ton, 2 1/2-Ton, 5-Ton
POMCUS	- Prepositioned Materiel Configured to Unit Sets
PTRF	- Peacetime Replacement Factor
RDAISA	- Research, Development, and Acquisition Information System Agency
SRC	- Standard Reference Code
SSN	- Standard Study Number
SSNS	- Standard Study Numbering System
TAA	- Total Army Analysis
TACV	- Special Analysis of Standard Tactical Wheeled Vehicle Requirements
TACV Addendum	- Addendum to the Special Analysis of Standard Tactical Wheeled Vehicle Requirements
TACV-EX	- Special Analysis of Standard Requirements Excursion, Tactical Wheeled Vehicles
TAEDP	- The Army Equipment Distribution Plan
TARCOM	- Tank-Automotive Research and Development
TDA	- Table of Distribution and Allowances
TOA	- Total Obligation Authority
TOE	- Table of Organization and Equipment
TRADOC	- Training and Doctrine Command
TWVRMO	- Tactical Wheeled Vehicle Requirements Management Office (LOGCEN)
TWVMO	- Tactical Wheeled Vehicle Management Office (DARCOM)
USAMMSA	- US Army Materiel Management Systems Agency
USAMSAA	- US Army Materiel Systems Analysis Agency
WARF	- Wartime Active Replacement Factor

WAR-SA	- Wartime Active Replacement for Special Allies
WHEELS	- Special Analysis of Wheeled Vehicles
XM1	- Main Battle Tank

EXECUTIVE SUMMARY

1. INTRODUCTION.

a. Background. Since the Army Special Analysis of the Wheeled Vehicles Study (WHEELS) in 1972-1973, Congress has questioned the Army concerning the implementation of study recommendations. As yet, the Army has not adequately explained, to Congress, the reasons why the Authorized Acquisition Objective (AAO) has fluctuated between and within the various weight classes of vehicles. Until recently, the Army has not had a system to capture the prime causes of the changes in vehicle requirements. This is now being developed. Since the completion of the WHEELS study, the Army force structure has changed significantly due to the introduction of modern weapons systems and the addition of three new combat divisions.

b. Study Directive. In response to questions from the Secretary of Defense and the House Appropriations Committee, the Secretary of the Army directed that a zero-based study of tactical wheeled vehicle requirements be conducted. As a result of this guidance, Headquarters, Department of the Army (HQ, DA) directed the US Army Training and Doctrine Command (USATRADOC) to conduct a study to examine tactical wheeled vehicles in terms of fleet composition and vehicle quantities. HQ, TRADOC subsequently directed the US Army Transportation School (USATSCH) to be the study agency under supervision of the US Army Logistics Center (USALOGC). The Army plans to use the Tactical Wheeled Vehicle Fleet study, after it has been approved, as the starting point of an audit trail of tactical wheeled vehicle requirements. The TRADOC Tactical Wheeled Vehicle Requirements Management Office (TWVRMO) is finalizing the methodology to provide periodic snapshots of the tactical wheeled vehicle requirements to provide the audit trail between budget years.

c. Study Objectives. The study was to accomplish the following objectives:

(1) Determine the payload categories and types of tactical wheeled vehicles which would best meet the needs of the Army.

(2) Prepare an acquisition program to include specification of the number, type, and cost of vehicles required to transition from the existing fleet to the preferred fleet.

(3) Develop an implementation schedule to align current requirements document's Table of Organization and Equipment/Basis of Issue Plans (TOE/BOIP) with study results.

d. Scope. The study was planned as an analysis of tactical wheeled vehicle requirements and assets as described below:

(1) The study considers current TOE and BOIP (new equipment but not new organizations) for which a defined Army master force structure need (active and reserve) exists through 1986. Requirements of the 1986 master (programed) force, as opposed to the current force, allow determination of a preferred vehicle fleet for which a transition plan can be developed and costed.

(2) The study considers the numbers and costs of tactical wheeled vehicles authorized by Tables of Distribution and Allowances (TDA) and Modification TOE (MTOE) in describing alternative fleets quantitatively. The rationale for this is that TDA and MTOE are the authorization documents used to determine the numbers of vehicles to be procured, whereas, TOE are the requirements documents used to determine the types of vehicles required by the Army.

(3) The study considers the current vehicle fleet along with planned acquisitions and projected losses as determined by US Army Development and Readiness Command (USADARCOM).

(4) The study considers the currently defined FY 86 Army master force as portrayed in the Force Accounting System (FAS) and Total Army Analysis (TAA) 86.

e. Methodology. The study develops equally effective, alternative tactical wheeled vehicle fleets for the Army and compares the 20-year program cost and manpower requirements for the alternative fleets. The detailed steps in the methodology are summarized in figure 1.

(1) First, TOE proponents analyzed tasks requiring tactical wheeled vehicles.

(2) The results were formatted as BOIP changes by TRADOC.

(3) The BOIP changes were applied to the force structure authorization for equipment maintained in the Logistics Structure and Composition System (LOGSACS).

(4) The resulting force structure authorizations for tactical wheeled vehicles were used in the Materiel Readiness System (MARS) to determine Authorized Acquisition Objectives (AAO) which consists of force requirements, TDA requirements, Prepositioned Materiel Configured to Unit Sets (POMCUS), special projects and contingencies, wartime consumption, mobilization training losses and special wartime active replacement--special allies.

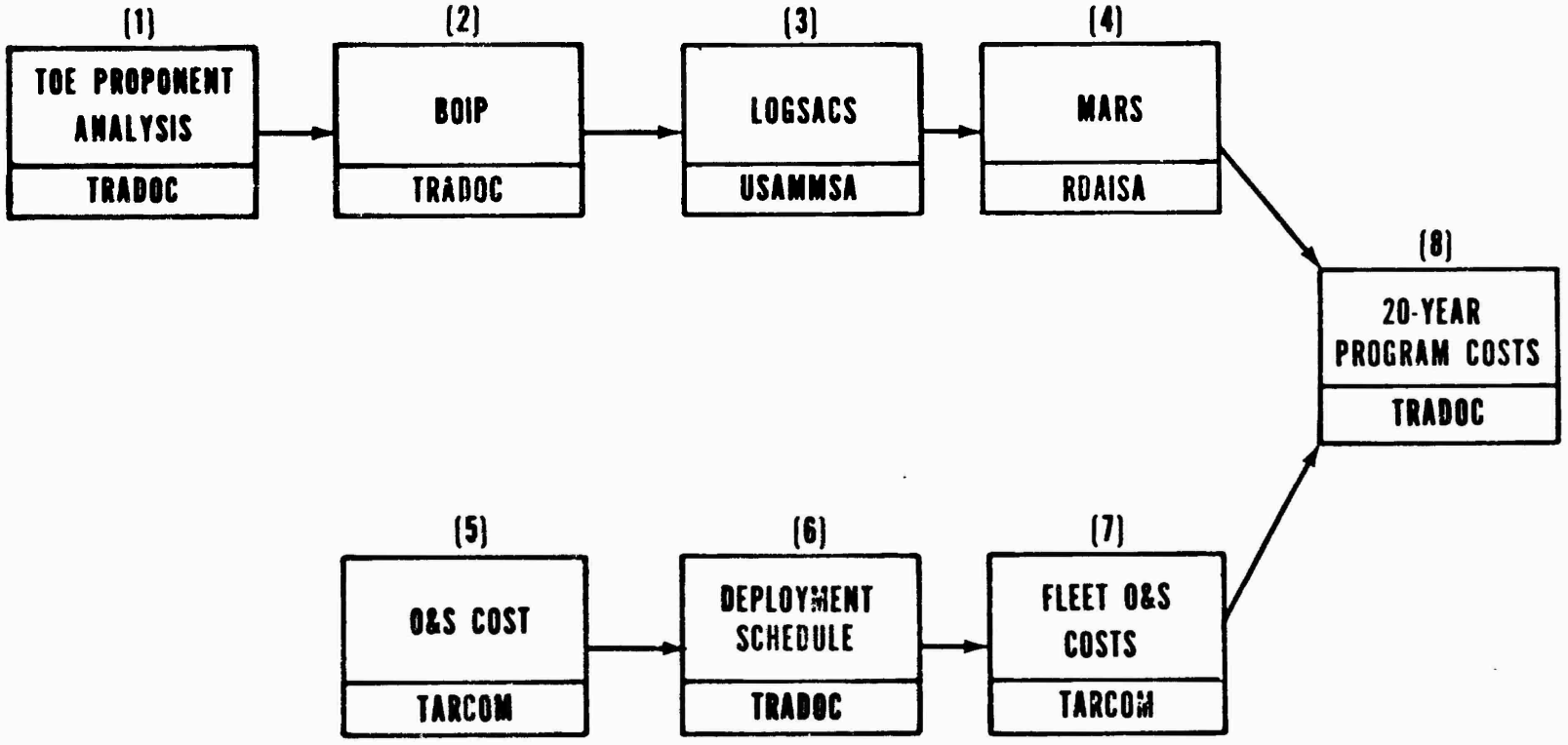


Figure 1. Methodology.

(5) Concurrent with the steps described above, Operating and Support (O&S) costs were developed for each vehicle by TARCOM.

(6) Deployment schedule data was developed by TRADOC based on distribution of assets.

(7) O&S costs for the fleet was calculated.

(8) Lastly, fleet O&S costs were combined with fleet procurement and development costs to determine the total cost of the tactical wheeled vehicle fleet over a 20-year period.

f. Data Bases for Study. The data used by the study includes:

(1) TOE current as of 6 May 1980.

(2) HQ TRADOC-approved BOIP as documented in BPP26RL (6 May 1980).

(3) The Army master force as documented in the Logistics Structure and Composition System (April 1980).

(4) Tactical wheeled vehicle asset status provided by DARCOM, current as of 30 September 1979.

(5) Cost data provided by DARCOM, current as of 31 July 1980.

2. ANALYSIS OF CONSTRAINTS, ASSUMPTIONS, AND LIMITS.

a. Constraints. The following constraints were used in the study to define and limit the alternatives considered.

(1) Elimination of 1/2-ton MULE and 8-ton GOER. Because some of the vehicle payload categories are no longer required (they are substitute items in some cases), or because there are only a few vehicles remaining in the inventory, and action is being taken to eliminate those vehicles from the fleet, the study group (in coordination with DARCOM) reduced the number of body styles of vehicles to be considered as requirements from 186 to 90 and in the process reduced the number of payload categories of trucks from 7 to 5. Two payload categories, the MULE and the GOER, were eliminated.

(2) Inclusion of 10-ton truck in each alternative mix. Based on the TRADOC-approved BOIP for a 10-ton truck (HEMTT) and supporting COEA (TACV Addendum), there is a validated requirement for the 10-ton truck in the Army to support Pershing II, Multiple Launch Rocket System (MLRS), Patriot, and the major users of ammunition (artillery, armor and mechanized infantry). Recognition of this requirement means that a 10-ton truck would be included in any alternative fleet.

(3) Truck-Tractors. The retention of five truck-tractors in each alternative fleet was based on their specialized capability and is justified by the following rationale:

(a) The M915 line haul truck-tractor was designed to pull semitrailer loads (containerized and break-bulk) weighing up to 34 short-tons (STONS).

(b) The M878 yard tractor was designed to quickly move trailer loads in support of port operations. This vehicle, required by the transportation terminal service company, has a hydraulic fifth wheel which eliminates the need to manually raise and lower trailer legs.

(c) The M916 light equipment transporter (LET) and the M920 medium equipment transporter (MET) were designed to transport light and medium engineer construction equipment.

(d) The M911 heavy equipment transporter (HET) was designed to transport the main battle tank (60 STONS).

(4) Affordability. In order to compare the resource requirements of fleet mix alternatives on an effectiveness basis, the study analyzes fleet mix alternatives at full Authorized Acquisition Objective (AAO) even though it is unlikely that the AAO will be procured with current fiscal limitations. This study best supports the Planning, Programing, and Budgeting System (PPBS) process by providing a complete picture of the Army's needs for tactical wheeled vehicles from which the impact of constrained resources can be measured.

b. Assumptions. The following assumptions were made in accomplishing the study:

(1) The current and projected Army Master Force establishes a valid requirement for the number of type units required by the Army. Specifically, the Army Master Force outlined in the FAS, dated April 1980, was used.

(2) The TOE/BOIP for type units of the Army are valid for purposes of this study except tactical wheeled vehicles. The intent of this assumption is to assure that this study be limited to a study of vehicles for Army units rather than a far reaching study of the organization of the units of the Army.

(3) The kinds of vehicles to be found in the proposed fleet can be determined by considering only the requirements which are derived from the needs of TOE units, as opposed to TDA organizations and MTOE units. TDA organizations use mostly administrative vehicles of kinds not to be examined in this study.

(4) The divergence of MTOE and TDA authorizations for tactical wheeled vehicles can be quantified as factored into proposed tactical

wheeled vehicle fleets. The purpose of this assumption is to permit a timely analysis of the Army's worldwide requirement for tactical wheeled vehicles by October 1980 via analysis of TOE's as opposed to analysis of 8,000 MTOE and TDA units by the Major Army Commands (MACOM).

c. Study Limits.

(1) The study does not analyze current or projected force structure (unit) requirements.

(2) The study does not analyze structuring of TOE's except for tactical wheeled vehicles required in TOE/BOIP.

(3) The study does not analyze MTOE requirements nor TDA requirements except as the number of vehicles impact on fleet quantities and costs.

(4) The study focuses on projected (1986) requirements in order to develop a modernization plan.

(5) The study uses the existing Army requirements and acquisition data bases in order to compare alternative fleets. Study results, therefore, may be used to support tactical wheeled vehicle requirements in the POM.

(6) The study does not determine:

(a) Tactical wheeled vehicle useful life.

(b) The cost-effectiveness of tactical wheeled vehicle rebuild versus replacement vehicle procurement policies.

(c) Priorities for distribution of new or replacement equipment.

(7) The study does not dictate structure of specific TOE's with regard to the functions to be performed by tactical wheeled vehicles. HQ TRADOC, on recommendation of the TOE proponent agency, is responsible for approving TOE changes.

(8) The study does not develop or establish the need for new tactical wheeled vehicle types and models. The study uses cost data for developmental vehicles and for new procurement of types presently in the fleet.

3. MISSION NEEDS. The basis for the type vehicles needed by the Army is found in the TOE.

a. The following seven different payload categories of trucks are now in use by the US Army: 1/4-T, 1/2-T, 5/4-T, 2 1/2-T, 5-T, 8-T, and 10-T and constituted the starting point for requirement development.

b. The TRADOC study group developed an evaluation strategy which was both comprehensive and yet manageable. This allowed the number of fleets mixes to be evaluated to be reduced to 9 from the potential of 127 that could be developed from seven payload categories. A synopsis of this strategy is as follows:

(1) The 8-ton Goer was eliminated as it is no longer planned for procurement.

(2) The 1/2-ton M-274 (MULE) was eliminated as both the US Marine Corps and the Army have determined that this special purpose payload category should not be retained.

(3) The 10-ton truck (HEMTT) will appear in all alternative fleet mixes.

(4) The remaining set of vehicles to be considered were placed into two groups for which there are distinct Army needs:

(a) Group A (command and control, light cargo) consists of 1/4- and 5/4-ton vehicles.

(b) Group B (prime movers and intermediate cargo) consists of 2 1/2- and 5-ton vehicles.

(5) Some of the requirements (light cargo) for vehicles in group A could be met using vehicles from group B, but this would be inefficient. Many of the towed loads requiring a vehicle prime mover from group B could not be pulled by 1/4- or 5/4-ton vehicles. Use of the 10-ton vehicle to perform payload independent tasks such as prime mover or shelter transport tasks currently required of 2 1/2-ton and 5-ton trucks is inefficient. This rationale allows further reduction of the mix alternatives according to the rule that a mix alternative must contain at least one vehicle from each of groups A and B.

(6) The nine mix alternatives retained for consideration are:

		Truck Payload Category (TON)				
Mix Alternative		Group A		Group B		
1	Base Case	1/4	5/4	2 1/2	5	10
2		-	5/4	2 1/2	5	10
3		1/4	-	2 1/2	5	10
4		1/4	5/4	-	5	10
5		1/4	5/4	2 1/2	-	10
6		1/4	-	-	5	10
7		-	5/4	2 1/2	-	10
8		1/4	-	2 1/2	-	10
9		-	5/4	-	5	10

c. Analysis of TOE requirements for tactical wheeled vehicles for each alternative was accomplished by the 20 schools/centers responsible for developing and documenting Tables of Organization and Equipment. A TOE proponent agency conference was conducted at the Transportation School to orient proponent agency representatives on the methods of analysis of TOE task requirements of trucks. The conference attendees were provided a study plan briefing, a briefing on the master force and BOIP, a briefing on the vehicle fleet and, lastly, a working session using TOE and the rules and guidance for task analysis from the study plan. The rules included:

(1) Maintain a capability to do the job equal to the base case.

(2) Choose the least number of vehicles to do the job for payload dependent tasks such as ammunition haul.

(3) Choose the smallest payload category vehicle where the task is payload independent, such as, command and control.

(4) Use trailers to the maximum extent feasible consistent with unit mission.

(5) Combine tasks where feasible.

d. Subsequent analyses of TOE by proponent agencies was staffed and approved by the school commandants and agency commanders prior to submission to the study group.

(1) Each TOE submitted by the proponent school/center was checked against the master list of standard requirement codes (SRC) scheduled to be in the FY 86 Force Accounting System (FAS) to ensure that all TOE in the FAS were analyzed by the responsible proponent.

(2) TOE worksheet was checked for format, to include proper Line Item Number (LIN), codes, and identification of primary and additional duty drivers.

(3) TOE worksheets were further checked to see if the rules and guidance for selecting alternative vehicles/trailers were followed and that reasonable explanations were provided in those cases where vehicle selection was contrary to the set rules and guidance (i.e., retention or selection of a vehicle/trailer that was not under consideration in a particular alternative).

4. DEVELOPMENT OF FLEET MIX ALTERNATIVES.

a. The methodology used in the study to expand the results of TOE analysis described above into the total Army requirement and procurement program for tactical wheeled vehicles for each fleet mix alternative is shown in figures 2, 3, and 4.

(1) Development of Force Requirements (fig 2). The Army process of development of force requirements for tactical wheeled vehicles is identified in the figure by solid lines. The process starts with analysis of TOE requirements to determine the types (payload categories) of vehicles needed by the Army. A manual update of TOE was done to account for the tactical wheeled vehicle requirements impact of emerging weapons systems and organizational changes planned through 1986. Generated requirements, for example, compressors which are required to be mobile and are mounted on trailers, were counted but were not task analyzed. The numbers of vehicles needed are determined from the modified TOE authorization documents used by Army units in the field multyplied by the number of units in the force structure corresponding to those MTOE. MTOE are routinely changed by BOIP to account for new or replacement equipment items. As indicated by the dashed arrow, the study group, in coordination with proponent agencies, did manual updating of TOE and used BOIP formats to configure the Army's authorization for tactical wheeled vehicles to the alternatives studied.

(2) Development of the AAO (fig 3). The second step in determining the Army's requirement for tactical wheeled vehicles is shown by the solid lines in the figure. The force requirement for tactical wheeled vehicles is extended to the Initial Issue Quantity (IIQ) by adding TDA authorizations and POMCUS. Special project and contingency requirements were added. Operational readiness floats, wartime consumption and mobilization training losses were factored and added to the IIQ. Lastly, wartime active replacement stocks for special allies was added. The result is the Authorized Acquisition Objective (AAO). The dashed lines indicate that the study group configured TDA, POMCUS, and MTOE residual authorizations (differences between TOE and MTOE) to the alternative mixes studied. Nine AAO's corresponding to the 9 alternatives were calculated in this manner.

(3) Development of Procurement Programs (fig 4). The procedure for determining the procurement programs (one for each alternative) is as follows:

(a) The starting vehicle assets in the tactical wheeled vehicle fleet are adjusted to account for planned receipts of new vehicles to yield a forecast of assets. The projected losses are calculated based on a peacetime replacement factor applied to vehicles in units and not to those in depot and POMCUS; hence, the factor is applied to the lesser of the IIQ or assets available.

(b) The forecast of assets is subtracted from the Authorized Acquisition Objective to determine the shortage of assets measured against requirements.

(c) The procurement program is then the lesser of shortages or production capability.

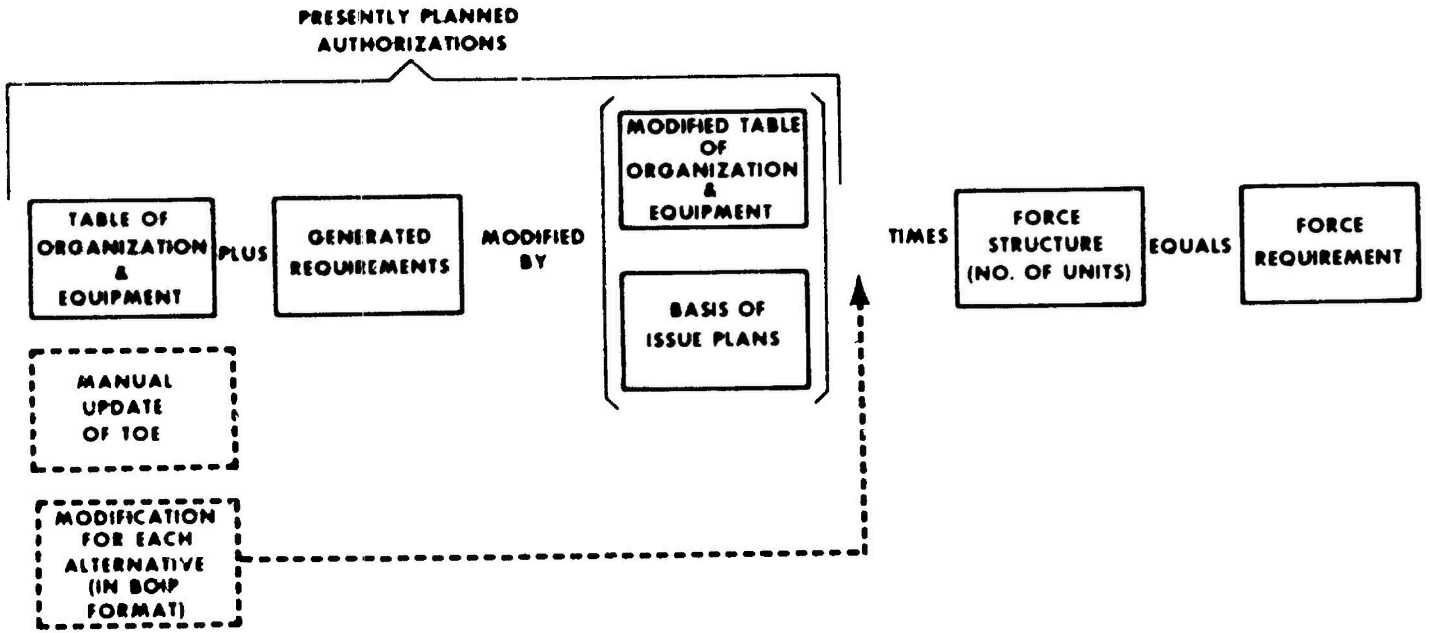


Figure 2. Development of force requirement.

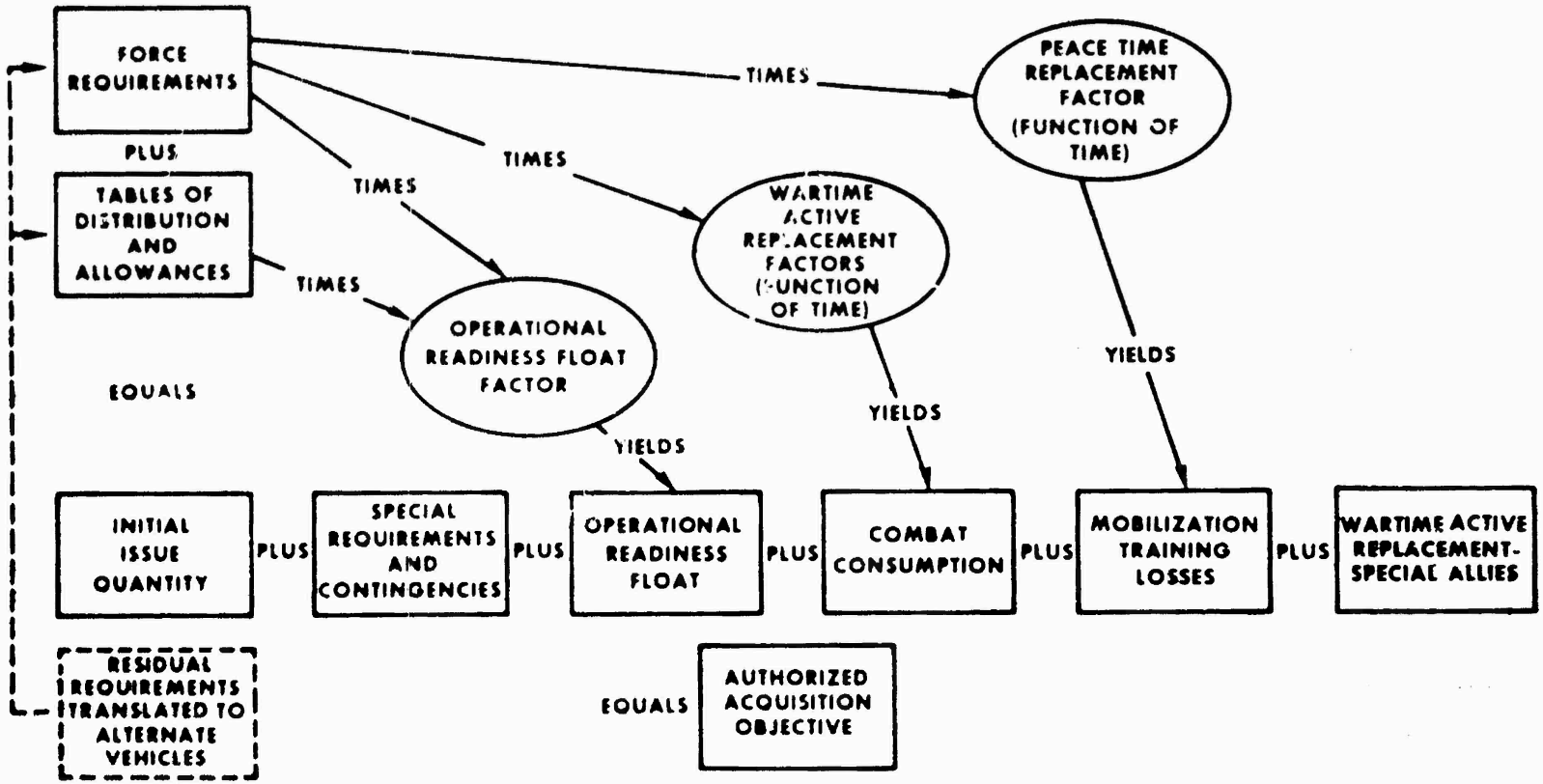


Figure 3. Development of the authorized acquisition objective (AAO).

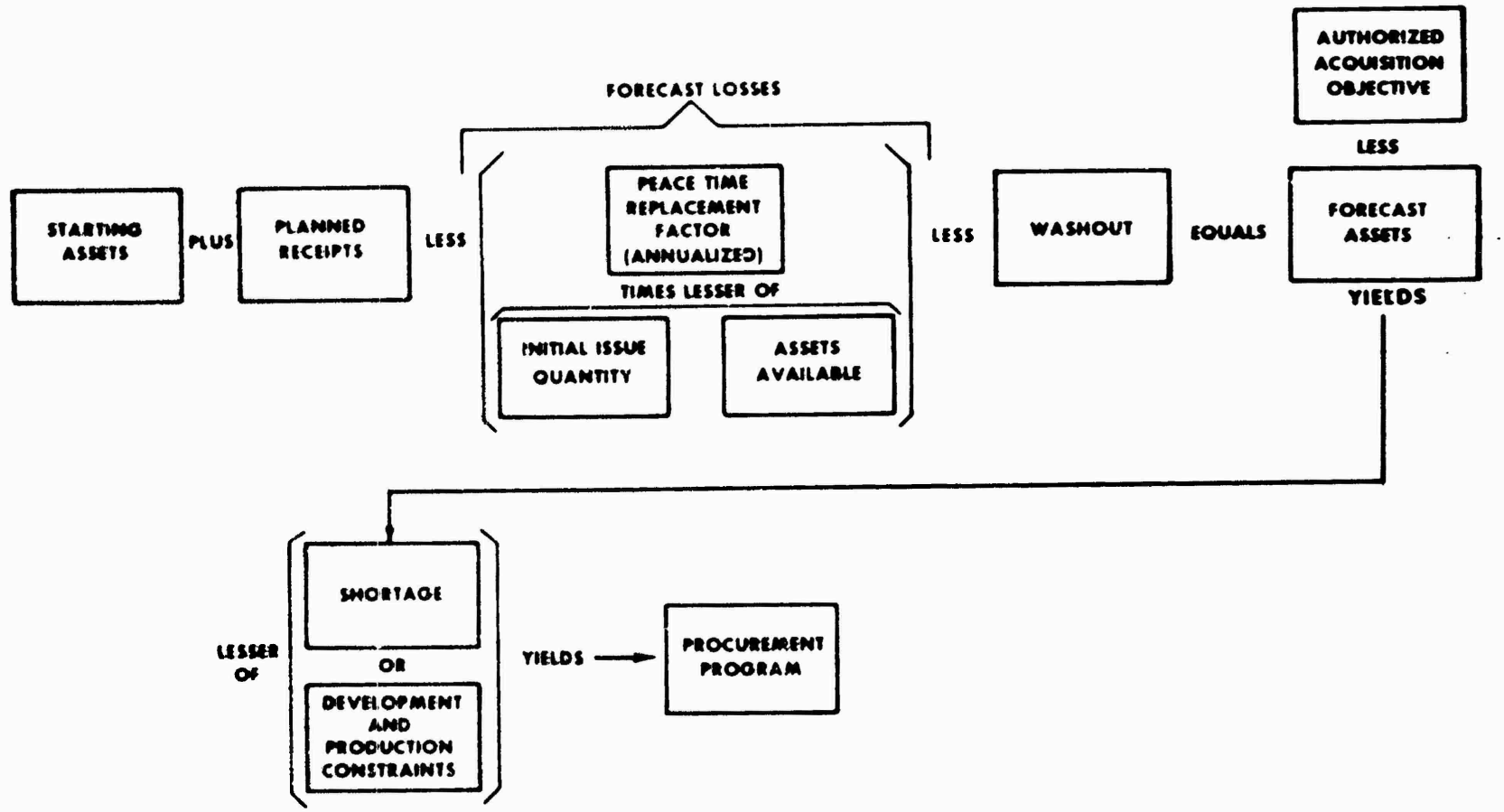


Figure 4. Development of procurement program.

(d) These calculations were made for each alternative for each of 20 years (1982-2001).

b. The entire process duplicates the normal procedure utilized in developing requirements and Army procurement programs, provides an acquisition plan to procure a preferred fleet, and provides a "strawman" document (BOIP) to update TOE and authorization documents as required by study objectives.

5. ANALYSIS OF RESOURCES.

a. The standard for comparison is the resource requirements of the base case (fleet mix 1). The factors for comparison include procurement costs, operating and support (O&S) costs, driver and mechanic requirements, and time needed to procure the fleet mix alternatives. All costs were developed in constant FY 82 dollars and were based on study production quantities provided by the Tactical Wheeled Vehicle Management Office (TWVMO) at TARADCOM. Production quantities used reflected consideration of minimum production rate, an economic order quantity production rate, and a maximum production rate. Hardware costs were based on a "representative" buy of each particular vehicle or trailer. For each standard study number (SSN), three investment cost estimates which defined a cost curve for any procurement quantity were fed into the MARS model for each alternative. The MARS model selected the production quantity most appropriate to a given year buy and multiplied the proper quantity of vehicles by the associated dollar values.

b. Operating and support costs were calculated based on assets in the fleet for each year of the 20-year program.

c. A display of the total cost to buy and maintain each alternative fleet, plus vehicle drivers, for 20 years is found in table 1. Only one alternative fleet mix, 2, is less costly (20-year life cycle discounted and undiscounted) than the base case, alternative 1.

d. Figure 5 depicts the percent deviation of each alternative from the base case in terms of drivers, mechanics, indirect and total personnel. The number of primary duty drivers was determined by TOE proponent analysis. No significant differences in driver requirements were found among alternatives; therefore, differences in the indirect and total manpower requirements in each alternative are directly related to differences in mechanic requirements. The mechanics needed for each alternative were calculated based on the MACRIT adjusted to mileage by geographic location to determine maintenance man-hours required by vehicle payload category and based on the distribution of vehicles needed by force component and by theater. Alternative 2 clearly requires fewer mechanics than all other alternatives (7 percent fewer mechanics than the base case) because all 1/4-ton requirements went to the 5/4-ton vehicles which require fewer mechanics than the 1/4-ton class with its associated trailers. The number of mechanics in alternatives 7 and 9 fall below the base case because they both include elimination of the 1/4-ton payload

Table 1. Total 20-year Program Costs for Each Alternative Fleet
(Constant FY 82 Dollars, Discounted, Billions)

Number	Alternative 1/4	5/4	2 1/2	5	10	Procurement + Development	Operating & Support (- Driver)	Driver	Total	Total Discounted
1	X	X	X	X	X	26.78	30.19	13.07	70.04	33.07
2	0	X	X	X	X	27.00	28.96	13.06	69.02	32.74
3	X	0	X	X	X	27.09	31.12	13.01	71.22	33.82
4	X	X	0	X	X	27.85	32.68	13.12	73.65	35.98
5	X	X	X	0	X	32.56	30.63	13.01	76.20	36.17
6	X	0	0	X	X	28.01	34.25	12.88	75.14	36.37
7	0	X	X	0	X	32.76	29.42	13.01	75.19	35.86
8	X	0	X	0	X	32.98	31.55	12.95	77.48	36.83
9	0	X	0	X	X	28.06	31.40	13.03	72.49	35.72

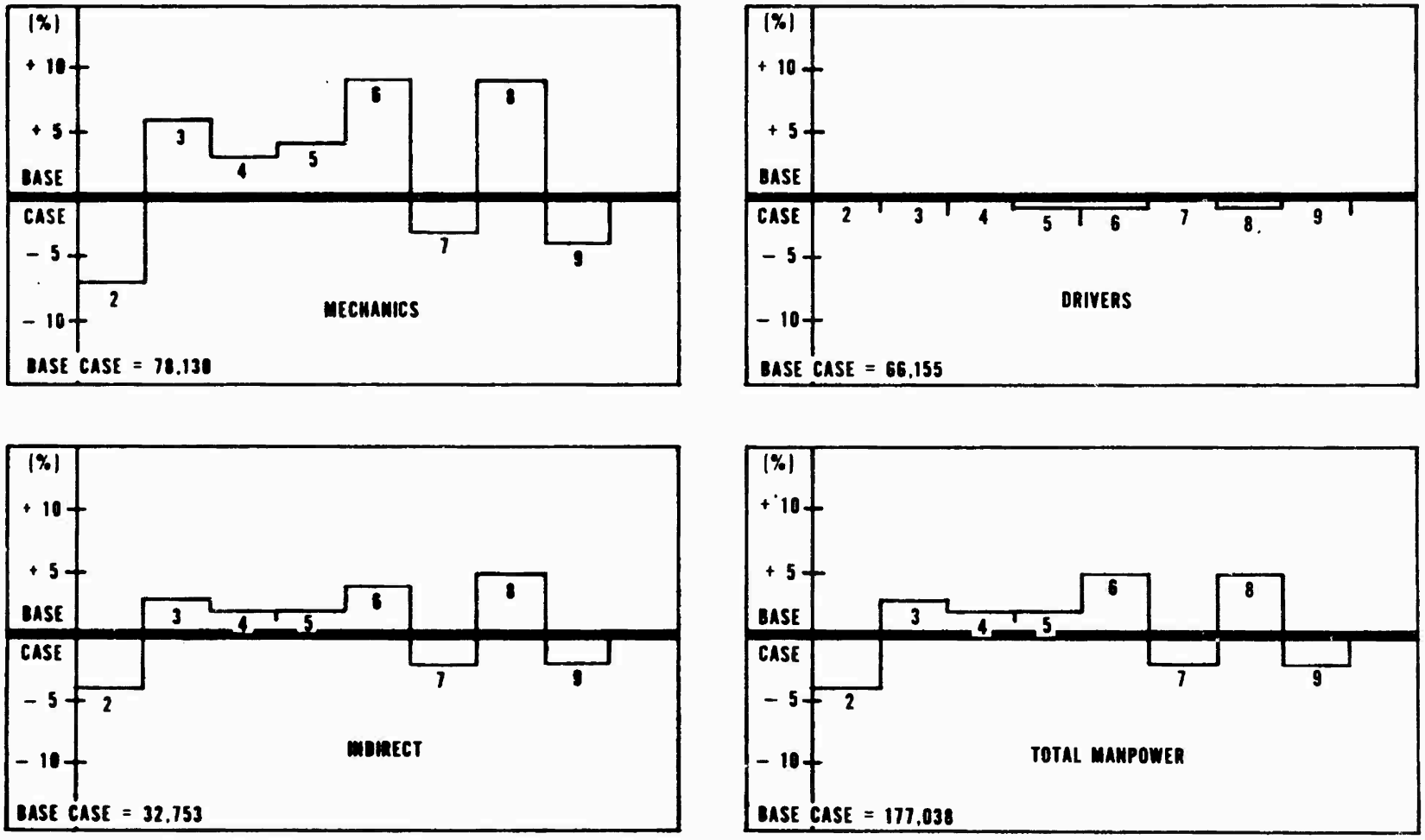


Figure 5. Manpower comparison.

class. All other alternatives require more mechanics than the base case because the substitute vehicle in each case requires more mechanics than the vehicle it is replacing.

e. The time to fill the AAO is primarily dependent upon developmental lead time, maximum production rate, and the age of current assets. The differences between alternatives did not exceed 1 year and could be adjusted in that range, in the judgment of acquisition planners, with minimum cost impact. For this reason, time to AAO was found to ba a nondiscriminator between alternatives.

6. ANALYSIS OF FLEET MIX ALTERNATIVES.

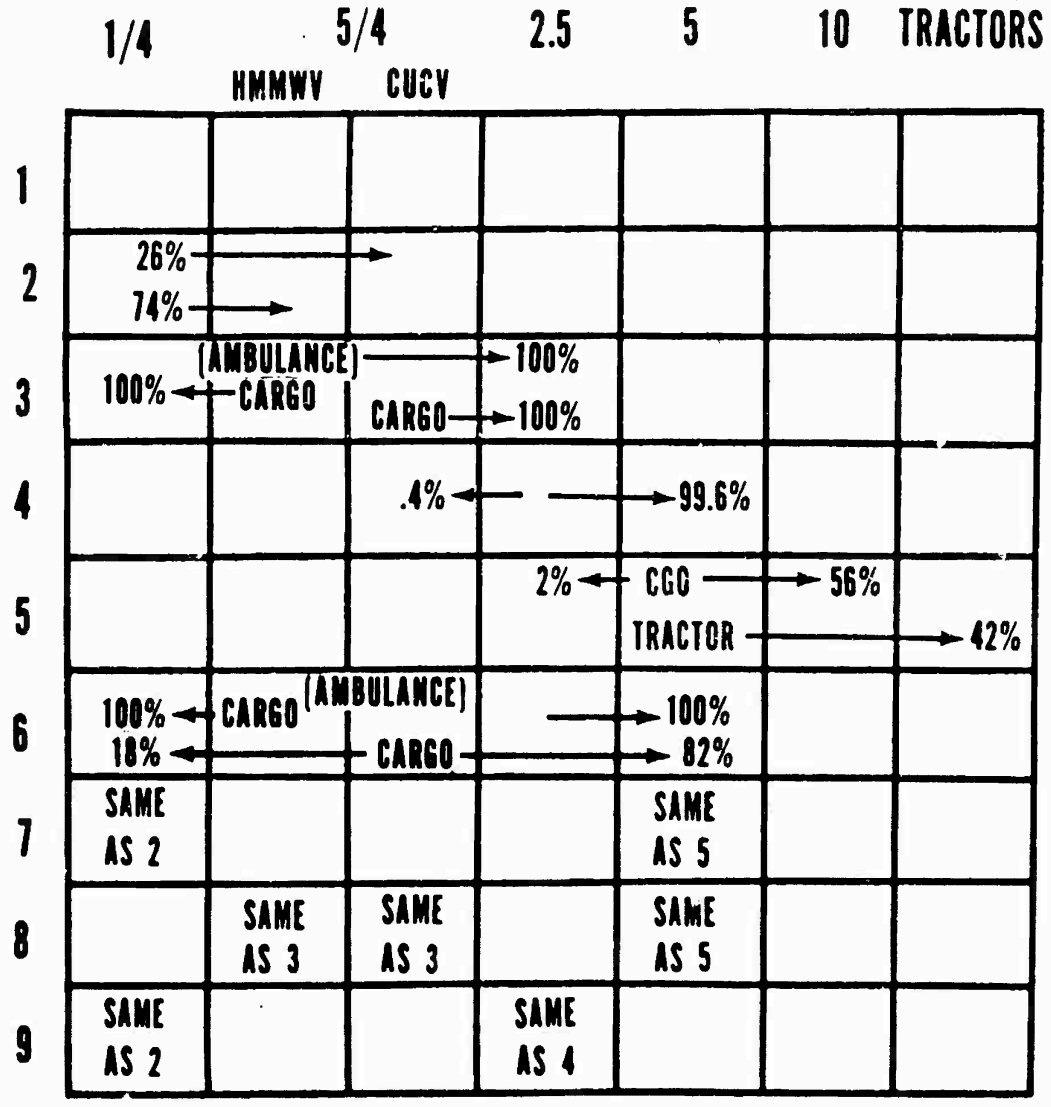
a. The base case (alternative 1) at full AAO was selected as the standard for comparison of the eight fleet mix alternatives. It represents the Army's currently planned fleet which consists of 1/4-, 5/4-, 2 1/2-, 5-, 10-ton trucks and tractors and associated trailers. The base case is developed, based on TOE that will be effective in 1986, and includes current TRADOC approved BOIP. The choice of 1986, as a focus for requirements, allows comparison of alternative acquisition plans and, as a result, program costs of each alternative. The 8-ton GOER does not appear as a requirement in the base case since it is replaced by 5- and 10-ton vehicles in the 10-ton HEMTT BOIP. Additionally, the base case replaces the 1/2-ton MULE with 1/4- and 5/4-ton vehicles and includes a new 5/4-ton commercial utility/cargo vehicle (CUCV) and HMMWV replacement for the M561 and M792 GAMA GOAT and 5/4-ton commerical type vehicles (M880) currently in the inventory.

b. Operationally, the base case fleet may be considered to be a satisfactory set of tactical wheeled vehicles capable of meeting the Army's needs in 1986. During analysis of tasks requiring vehicles, a conscious effort was made by TOE proponents to hold the capability of the base case equal to that specified in TOE and BOIP documents while applying changes to 1/2-ton MULE and 5/4-ton GAMA GOAT vehicles. There are, in fact, shortages of tactical wheeled vehicles and overload conditions in certain TOE that should be corrected. By agreement, these TOE were not changed for purposes of study consideration, even though corrections are being processed by TRADOC through the normal TOE change process. In the development of alternative fleets, TOE proponent agencies were directed to use the same set of tasks requiring vehicles and to hold fleet capabilities constant across the alternatives in order to develop equally effective alternative fleets for the study.

c. The major shifts in vehicle requirements are summarized in table 2. The resulting quantities for the major vehicle types are displayed in table 3. Analysis of these tables indicates the following:

(1) The TOE analysis by proponents resulted in vehicle replacement ratios that came close to 1:1 between the alternative mixes. Payload independence of tasks, battlefield flexibility, payload volume and general support transportation unit capability are the primary reason

Table 2. Shifts in Fleet Composition



for the 1:1 substitution ratio. For example, figure 6 shows that 94 percent of tasks now performed by 2 1/2-ton trucks are payload independent tasks and could require a 1:1 substitution of a 5-ton truck in a fleet with no 2 1/2-ton trucks.

(2) Elimination of the 1/4-ton truck in alternatives 2, 7, and 9 can be achieved to a high degree by placing 1/4-ton requirements on the 5/4-ton payload category of vehicles on about a 1:1 basis. A significant reduction in trailer requirements results from elimination of 1/4-ton trailers along with 1/4-ton trucks. The variances in 5/4-ton requirements in alternatives 7 and 9 are due to elimination of 5-ton and 2 1/2-ton trucks, respectively, as well as the 1/4-ton vehicle.

(3) Alternatives 3, 6, and 8 incidate that TOE proponents could not entirely eliminate the 5/4-ton payload category of vehicles due to nonavailability of required vehicle types. Based on DARCOM engineering estimates, suitable alternative vehicles (in other payload categories) could be developed using vehicle chassis currently programed for the fleet for most requirements. However, HMMWV type weapons carriers required in alternatives 3, 6, and 8 and for the ambulances needed in alternative 6 could not be replaced with a readily available substitute in another payload category.

(4) Elimination of the 2 1/2-ton truck in alternatives 4, 6, and 9 can be achieved except for a small number of 2 1/2-ton trucks needed by airborne and airmobile units. The bulk of the 2 1/2-ton vehicles not replaced in these alternatives are specialty vehicles, such as the M109 shop van, for which there was no suitable replacement in another payload category. The use of "dummy" replacement vehicles (considered by DARCOM engineers to be feasible modifications to vehicles in the fleet and by proponents to be suitable for mission accomplishment) were used in the study; for example, a 5-ton "dummy" vehicle shop van was used as a replacement for the 2 1/2-ton shop van.

(5) Elimination of the 5-ton truck in alternatives 5, 7, and 8 can only be achieved by development of additional types of "dummy" vehicles in the 10-ton and tractor categories of vehicles, particularly the dump truck, tractor, tractor wrecker, and expansible van types of vehicles.

(6) The total truck and tractor requirements column indicates no significant difference in alternative requirements for numbers of prime mover vehicles. Significant trailer requirements reductions are indicated for alternatives 2, 7, and 9.

d. The criterion of choice established in the study plan (app B) established the need to consider nonquantifible factors that could impact on analysis of fleet mixes. During the course of the study, the following factors were identified and considered relevant for analysis.

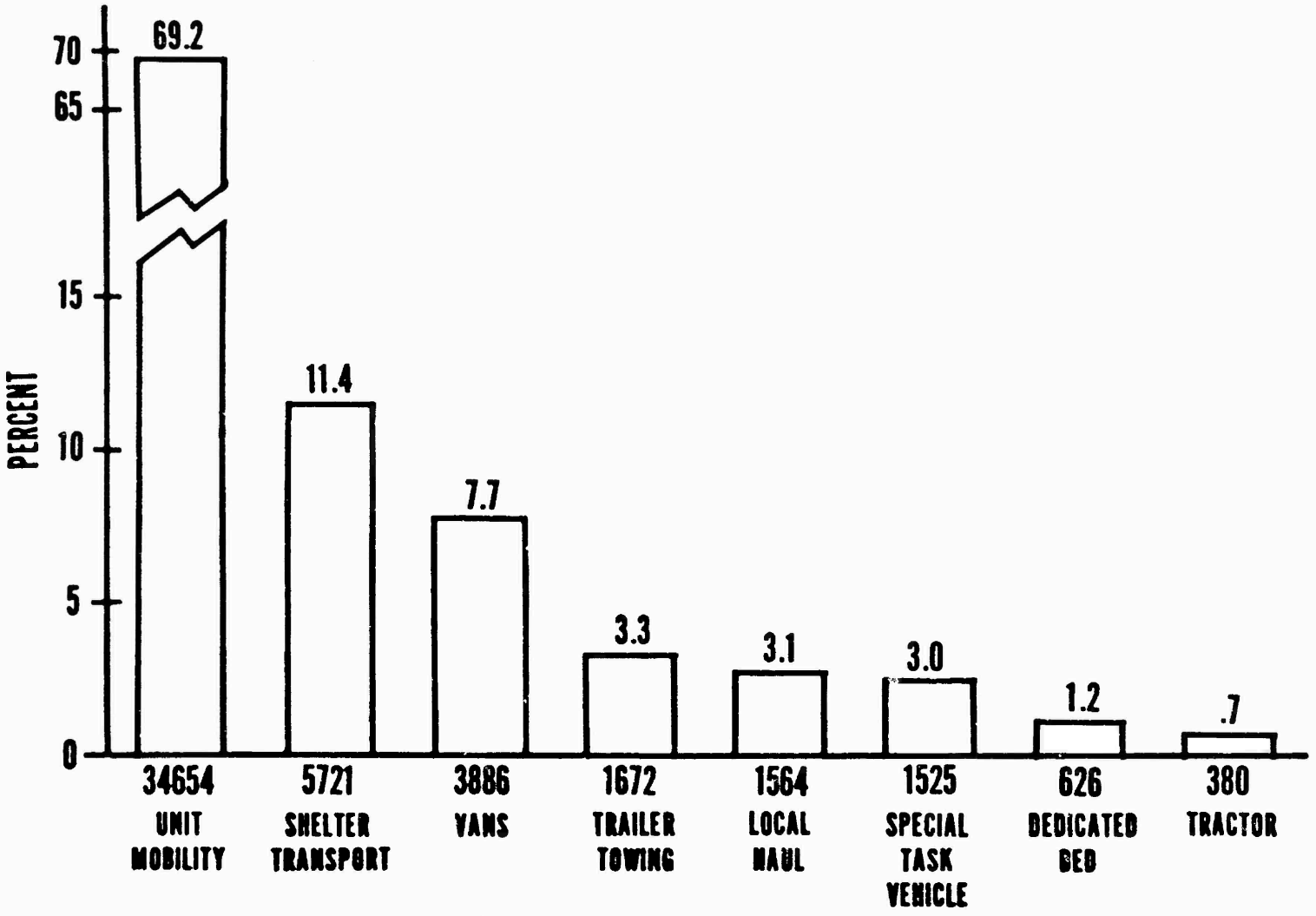


Figure 6. 2 1/2-ton truck distribution by primary mission.

(1) Factor A. A lesser number of payload categories should result in (1) increased proficiency and productivity of drivers and mechanics; (2) reduced training requirements in the training base and in units; and (3) reduced parts stockage at all levels of maintenance.

(2) Factor B. A larger fleet cargo capacity should provide increased capability for payload dependent tasks, especially to satisfy surges; and provides potential to meet growth in TOE equipment, increased need for survivability; and increased demand for support of more complex material items.

(3) Factor C. A greater number of payload categories should assure improved matching of vehicles to mission tasks.

(4) Factor D. Fleet mixes which place lesser demands for mechanics are to be preferred. Track and wheeled vehicle mechanics are in short supply in the Army and the situation will most likely worsen.

(5) FACTOR E. Fleet mixes containing 2 1/2-ton and lighter cargo vehicles are more readily deployable both intertheater and intratheater.

e. Table 3, total vehicle requirements by payload category together with table 4, fleet cargo capacity, present the results of analysis. It will be noted in table 3 that the 5/4-ton vehicle number are circled for alternatives 3, 6, and 8. No substitute vehicles for the XM966 weapons carrier is readily available. Further, there is no replacement readily available for the 5/4-ton ambulance in alternative 6.

f. Discussion of Results.

(1) The lesser number of payload categories found in alternatives 7 and 9 tend to favor them for Factor A.

(2) Alternative 1 (base case) with its greater number of payload categories and large numbers of 2 1/2-ton and lighter cargo vehicles favor it for Factors C and E.

(3) The larger truck fleet capacities of alternatives 4, 6, and 9, shown in table 4, favors them for Factor B.

Table 3. Total Vehicle Requirements by Payload Category

ALT	1/4	5/4	2½	5	10	TRACT	TOT. TRKS	TRAILERS	TOTAL	△
1	111.6	93.7	100.8	59.8	21.7	12.4	400.0	225.9	625.9	0
2	–	198.7	100.8	55.8	21.7	12.4	393.4	177.1	570.5	-55.4
3	129.5	(1) (5.1)	166.4	59.8	21.7	12.4	394.9	216.4	611.3	-14.6
4	111.6	94.1	(3) (0.2)	160.3	21.7	12.4	400.1	225.9	626	+0.1
5	111.6	93.7	102.8	–	54.1	37.6	399.8	225.3	625.1	-0.8
6	143.5	(2) (11.7)	(3) (0.2)	209.8	21.7	12.4	398.3	216.4	614.7	-11.2
7	–	198.7	102.5	–	54.1	37.6	392.9	176.5	569.4	-56.5
8	129.5	(1) (5.1)	168.4	–	56.1	37.6	396.7	217.1	613.8	-12.1
9	–	199.1	(3) (0.2)	166.2	21.7	12.4	393.4	177.1	570.5	-55.4

(1) Significant numbers of weapons carriers required for which there was no substitute vehicle readily available in another payload category.
(2) In addition to weapons carriers, 6,600 ambulances were retained because no substitute was readily available.
(3) Less than 200 2 1/2-ton trucks required by airborne/airmobile units.

Table 4. Truck Fleet Cargo Capacity (thousands of tons)

Alternative	1/4	5/4	2 1/2	5	10	Totals
1	27.9	117.1	252	299	217	913
2	--	284.4	252	299	217	1016.4
3	32.8	6.4	416	299	217	971.2
4	27.9	117.6	--	801.5	217	1164.0
5	27.9	117.1	257	--	541	943
6	35.9	14.6	--	1045	217	1312.5
7	--	284.4	256.3	--	541	1045.7
8	32.8	6.4	421	--	561	1021.2
9	--	250	--	807.5	217	1274.5

(4) From figure 5, the lesser demands for mechanics in alternative 2, 7, and 9 favor them for Factor D.

7. UNCERTAINTIES AND SENSITIVITIES.

a. Uncertainty of Ammunition Expenditure Impact on Study Results. Early in the study, the Study Advisory Group (SAG) directed that the validity of TOE tasks requiring tactical wheeled vehicles be analyzed in detail for selected units in order to support the study assumption that TOE requirements for tactical wheeled vehicles were valid requirements. The results of the analysis indicated that TOE with changes to incorporate the XM1, and IFV/CFV in armor and mechanized infantry units were valid as was the field artillery requirement for additional trucks needed to provide fuel and ammunition.

b. Uncertainty of Requirements for Tactical Wheeled Vehicles, 1987-2001. The study uses a 20-year (1982-2001) program cost to compare alternatives. The 20-year program cost was used in order to capture the costs of vehicles with varying useful lives in addition to capturing the total cost associated with acquisition and support of the Army's tactical wheeled vehicle fleet. The Army's projection of vehicle requirements does not extend past 1986. A display of program costs for each alternative discounted at 10 percent per year is provided in table 3. This procedure allows comparison of opportunity costs, and also serves to weight the early years where requirements are more accurately known.

c. Uncertainty of Wartime Active Replacement Factor (WARF). The Concepts Analysis Agency generates the wartime active replacement factors based on simulations of forces equipped with the currently planned tactical wheeled vehicle fleet. From this, the currently planned FY 86 distribution of the types of vehicles in the fleet is determined. The major contributing factor to the attrition rate for each type of vehicle is its location on the battlefield.

d. Sensitivity of Program Costs to Extension of Vehicle Useful Life. The 20-year program costs of the alternatives depend on the status of assets in the alternative fleets. The cost of life extension versus the cost of procuring new vehicles and the cost of O&S for the extended fleet versus O&S with new RAM improved vehicles was examined for alternative 1 (base case) by extending the useful life of vehicles in the fleet by 25 percent. The results of the base case extended life versus base case indicate a reduction in overall program costs for the base case extended life of 8 percent.

e. Sensitivity of Alternative Program Costs to Contributing Cost Factors. The major contributing factors to 20-year program costs are indicated below for alternative 1, the base case.

Cost Factors By Percentages - Base Case

	Development	Less than one-tenth of a percent
	1st and 2d Dest Trans	3%
	Acquisition	38%
TOTAL	Procurement	41%
	Repair Parts, POL, Modification	14%
	Driver	19%
	Mechanics, Indirect	26%
TOTAL	O&S	59%

f. Sensitivity of Results to Acquisition Planning. Use of the MARS model to produce the acquisition plan for each alternative examined in the study required several iterations to produce an optimal acquisition plan. This process required DARCOM acquisition planners to interact with the MARS model to ensure that unrealistic buys and alternatives resulting in cheaper procurement costs were not made by the model. The optimization programing available in the model at this time does not adequately address family buys when operating without a funding constraint. Yearly options to force vehicle buys, available in the model, were used by the acquisition planners to cure this problem.

8. PREFERRED ALTERNATIVE.

a. Criterion of Choice (Study Plan Appendix B). "This study will be essentially a fixed effectiveness variable cost study. Proponent

agencies will maintain current capabilities of unit tactical wheeled vehicles when selecting alternative mixes of vehicles. Because of efficiencies due to reductions in numbers and types of vehicles Armywide, it is expected that one or more of the fleet alternatives will be cheaper than the current fleet. One of these fleet alternatives will be selected as the preferred fleet with due consideration of nonquantifiable matters that could impact on preferences."

b. Quantifiable Factors.

(1) Numbers of Vehicles. From table 3, section 6, seven of the eight alternative fleets studied showed reductions in total numbers of vehicles from those found in the baseline (al ernative 1 - table 3). Three alternative mixes; 7 (-56.5 thousand), 2 (-55.4 thousand) and 9 (-55.4 thousand) clearly are dominant.

(2) Types of Vehicles (Payload Categories). Only two alternatives were developed with three truck payload categories: alternatives 7 and 9. All others contained at least four payload categories. It is to be noted that the objective of achieving three truck payload categories for alternatives 6 and 8 was unattainable due to an inability to maintain fixed effectiveness for all types of units.

(3) Fleet Costs. From table 1, section 5, alternative 2 is the only fleet mix which is cheaper (total 20-year life cycle and total 20-year life cycle discounted) than the baseline alternative 1. It is to be noted that the cost difference between the baseline (alternative 1) and the cheaper alternative is about $330 million (discounted costs) or about 1 percent different from the baseline costs of $33.07 billion.

(4) Quantitative Summary. Thus, using the quantitative portion of the presented criterion of choice, three fleet mix alternatives are found to qualify.

	1/4	5/4	2 1/2	5	10
Alternative 2	0	X	X	X	X
Alternative 7	0	X	X	0	X
Alternative 9	0	X	0	X	X

c. Nonquantifiable Factors. Section 6 of the report introduced the nonquantitative factors developed by the study team. These are reported below to assist in developing the preferred alternative.

(1) Description of factors.

(a) Factor A. A lesser number of payload categories should result in (1) increased proficiency and productivity of drivers and

mechanics; (2) reduced training requirements in the training base and in units; and (3) reduced parts stockage at all levels of maintenance.

(b) Factor B. A larger fleet cargo capacity should provide increased capability for payload dependent tasks, especially to satisfy surges, and provides potential to meet growth in TOE equipment, increased need for survivability, and increased demand for support of more complex material items.

(c) Factor C. A greater number of payload categories should assure improved matching of vehicles to mission tasks.

(d) Factor D. Fleet mixes which place lesser demands for mechanics are to be preferred. Track and wheeled vehicle mechanics are in short supply in the Army and the situation will most likely worsen.

(e) Factor E. Fleet mixes containing 2 1/2-ton and lighter cargo vehicles are more readily deployable both intertheater and intratheater.

(2) Discussion of Nonquantifiable Matters.

(a) Factor A, lesser number of payload categories, favors the two 3 truck fleet mixes, alternatives 7 and 9.

(b) Factor B, larger fleet cargo capacity, favors in order: alternative 9 (1.2745 million tons); alternative 7 (1.0457 million tons); and alternative 2 (1.0164 million tons).

(c) Factor C, better matching one mission tasks to vehicle, favors alternative 2, the only remaining alternative with four payload categories.

(d) Factor D, lesser demand for mechanics, favors in order; alternatives 2, 9, and 7 (fig 5).

(e) Factor E, deployability, alternatives 2 and 7 contain the 2 1/2-ton vehicles which from size and weight considerations should be more readily deployable than the 5-ton vehicles.

(3) From paragraph 8b(4) above, three alternatives (2, 7, and 9) were selected using the quantitative criteria. These alternatives were subjected to evaluation using the nonquantifiable factors. The results of the nonquantitative analysis showed that no one alternative was clearly dominant; however, using equal weighing of all nonquantifiable factors, a slight advantage is seen in alternative 2.

d. Overall Summary. Use of the quantitative portion of the Criterion of Choice finds that of the nine alternatives, three fleet mixes satisfy two or more of the three quantitative factors; alternatives

2, 7 and 9. Equal weighting of all factors, quantitative and nonquantitative, favors alternative 2 as the preferred alternative.

9. ESSENTIAL ELEMENTS OF ANALYSIS.

a. Introduction. Seven essential elements of analysis (EEA) were identified in chapter 1. These seven EEA were considered as key to the development of study results. Each element was formulated as a question that was specifically targeted at the study objectives.

b. Element 1.

(1) Element of analysis: What quantities and mixes of tactical wheeled vehicles are required for mission accomplishment?

(2) Analysis Results: The mission of the tactical wheeled vehicle fleet can be accomplished equally effectively by different combinations of vehicles by varying the number of each payload category vehicle available to perform the mission. All combinations (or alternatives) considered are based on TOE effective in 1986 and include the impact of current TRADOC-approved BOIP. (See table 3.)

c. Element 2.

(1) Element of analysis: What is the developmental, procurement, and operating cost for 20 years of fleet operations?

(2) Analysis results: Twenty-year program costs were calculated for each alternative in FY 82 constant dollars. The program cost for each alternative includes procurement, developmental, operating and support, and vehicle driver costs. Total costs were discounted 10 percent per year to compare opportunity costs for each fleet mix alternative. (See table 1.)

d. Element 3:

(1) Element of analysis: Which alternative fleet will accomplish the mission at the least cost?

(2) Analysis results:

(a) Fleet alternative 2 can accomplish the mission at least cost. Its total 20-year program cost is $69.02 billion. This total discounted becomes $32.74 billion.

(b) The next closest cost-competitive fleet is the base case. Its total program cost is $70.04 billion--$1.02 billion in excess of the least cost alternative. The total discounted cost of the base case is $33.07 billion--.33 billion in excess of the least cost alternative.

e. Element 4.

(1) Element of analysis: What is the preferred fleet of wheeled vehicles to satisfy the Army's needs based on present organizations? Based on Army 86?

(2) Analysis results: An analysis based on the quantitative factors found in the Study Plan Criterion of Choice shows that three alternative mixes are dominate over all others: alternatives 2, 7 and 9. When considering both quantitative and nonquantitative factors, equal weighting favors alternative 2 as the preferred alternative.

f. Element 5.

(1) Element of analysis: For each vehicle type in the preferred fleet, what is the quantity required and the time phasing necessary to replace existing vehicles in the current fleet as they exceed age/condition criteria for retention?

(2) Analysis results: The procurement plan for the preferred fleet (along with all other alternatives) was developed utilizing the established procedures for procurement planning except that budget constraints were not imposed on the process. See chapter 4 for an explanation of this process. Table 5 shows the quantity of vehicles by category required for each year to replace projected peacetime losses over 20 years. For each specific vehicle type in the preferred fleet, procurement quantities and time-phasing of needs are displayed in the procurement output of the MARS model maintained by the RDAISA at Radford, Virginia.

g. Element 6.

(1) Element of analysis: What acquisition strategy/plan can be developed to support the preferred fleet?

(2) Analysis results:

(a) The acquisition strategy for the preferred fleet takes into consideration all of the considerations normally involved in procurement planning, i.e., vehicle families, multi-year contracts, minimum buy quantities, maximum buy quantities, economy of quantity, and limitation on procurement period for commercial substitute vehicles. All of these constraints and trade-offs were developed and staffed through the TARCOM and TARADCOM acquisition experts and are based on the same criterion normally utilized for development of the tactical vehicle procurement plan for budget submission.

(b) Table 5 reflects the acquisition strategy developed to support the preferred alternative. Specific vehicle types that are based on common chassis are categorized in table 5 by their highest density body style. The quantity of vehicles along with their costs are

Table 5. Multi-Item Facility Procurement Program

08/07/78 17:05:24 ALTERNATIVE 2

(DOLLAR COST IN MILLIONS)

YEAR	TOTAL PROGRAM COST	M880 ...D11103... QTY	M880 COST	2½Ton ...D13103... QTY	2½Ton COST	5 TON ...D14002... QTY	5 TON COST	8 TON ...D15102... QTY	8 TON COST	M809AV ...D15303... QTY	M809AV COST	M915 ...D15900... QTY	M915 COST	M911T ...D16201... QTY	M911T COST
1976	918.6	0	.0	0	.0	3000	228.3	0	.0	0	.0	3377	201.9	300	52.6
1977	1950.9	0	.0	0	.0	8000	672.1	0	.0	0	.0	3377	201.9	4500	773.9
1978	2900.2	29060	383.1	3000	193.3	8000	615.9	0	.0	3515	99.3	0	.0	9000	1551.6
1979	3950.5	29060	386.0	20000	910.5	8000	585.5	0	.0	14900	396.0	0	.0	6628	1149.8
1980	4318.5	29060	366.8	20000	889.5	8000	603.1	0	.0	14900	399.9	0	.0	0	.0
1981	1915.6	0	.0	20000	993.9	5307	919.9	0	.0	14900	399.1	0	.0	0	.0
1982	1584.2	0	.0	20000	913.8	3139	237.3	0	.0	14900	352.7	0	.0	0	.0
1983	1939.2	0	.0	14981	784.9	3003	215.9	0	.0	14900	398.6	0	.0	0	.0
1984	803.6	0	.0	3000	152.7	4960	331.8	0	.0	14900	399.9	0	.0	0	.0
1985	901.0	0	.0	3000	193.9	4293	327.3	0	.0	14900	397.9	0	.0	0	.0
1986	1126.5	29060	382.9	0	.0	4823	419.3	0	.0	9939	230.1	648	33.1	0	.0
1987	677.8	29060	382.9	0	.0	0	.0	0	.0	0	.0	2219	119.8	471	80.9
1988	736.3	25931	380.0	0	.0	0	.0	0	.0	0	.0	1463	99.9	1026	180.0
1989	93.3	0	.0	0	.0	0	.0	0	.0	0	.0	0	.0	0	.0
1990	79.7	0	.0	0	.0	0	.0	0	.0	0	.0	0	.0	0	.0
1991	662.9	0	.0	2400	115.1	0	.0	0	.0	7200	185.6	3282	196.8	0	.0
1992	863.0	0	.0	0	.0	3212	256.3	0	.0	11220	271.5	3362	200.9	0	.0
1993	398.8	0	.0	0	.0	0	.0	0	.0	14218	398.1	0	.0	0	.0
2000	1006.7	29060	382.9	9602	216.8	0	.0	0	.0	14252	396.3	0	.0	0	.0
2001	1578.9	29060	382.9	16557	751.3	0	.0	0	.0	14267	398.0	0	.0	309	57.9
TOTAL	25472.9	232291	3059.9	129520	5964.7	63182	4901.7	0	.0	174906	4268.9	17728	1054.2	22229	3862.3

NOTE: Due to computational procedures these costs may show minor variations from other data.

displayed for the year in which procurement is required. Those specific vehicles that do not involve family relationships would be procured according to the quantity and time schedule displayed in the procurement output of the MARS model maintained by the RDAISA at Radford, Virginia. The procurement output of the MARS model contains specific quantity, cost, and time-phasing data for every vehicle in alternative 2.

h. Element 7.

(1) Element of analysis: What is the implementation schedule needed to change requirements and authorization documents to reflect study results?

(2) Analysis results: BOIP changes for requirements and authorization documents that reflect the appropriate number and type of vehicles and drivers for each unit have been developed and put on file as "strawman" BOIP documents at the Data Processing Field Office, US Army Combined Arms Center and Fort Leavenworth Combat Developments Activity, Fort Leavenworth, Kansas. These "strawman" BOIP documents will serve to amend TOE to reflect the type and quantities of vehicles and drivers that would be required by implementing any one of the various alternatives. These BOIP would need to be updated to accomplish other changes (e.g., mechanics, etc.) necessitated by the introduction of these changes in number and type of vehicles and drivers. The updated BOIP should be accomplished as part of the normal TOE updating process done by TRADOC agencies.

10. FINDINGS.

a. Preferred Alternative. The study group prefers alternative 2 (5/4-, 2 1/2-, 5-, and 10-ton trucks) as a tactical wheeled vehicle fleet that meets the study purpose of reducing the number and types of vehicles, saving resources (both dollar and manpower), without degrading combat effectiveness of the Army's tactical wheeled vehicle fleet.

b. Other Findings. The study findings presented are those of the Commandant, US Army Transportation School, and should not be considered as Headquarters, Training and Doctrine Command or Department of the Army policy or guidance unless so stated in approval documents published by that headquarters.

(1) The tactical wheeled vehicle fleet development process as studied is a repeatable methodology that generates basis of change for Table of Organization and Equipment and acquisition plans to procure the fleet.

(2) The trend in development of Tables of Organization and Equipment is to eliminate the 1/4-ton truck, as evidenced by the development of the High Mobility Multipurpose Wheeled Vehicle for weapons

carrier and command and control tasks and by acceptance of the M880 5/4-ton commerical vehicle to perform tasks previously done by the 1/4 ton truck.

(3) When Table of Organization and Equipment proponent agencies are required to select an alternative vehicle, the trend was to select a higher payload category rather than to select two or more smaller vehicles to do the same job. This indicates that the TOE designers have selected the smallest vehicle capable of doing the task in the current fleet. It also indicates careful design of TOE to minimize personnel assets needed for tasks.

(4) As discussed in paragraph 6, vehicle replacement ratios approached a 1:1 between alternative mixes.

(5) There is a trend toward larger vehicles to compensate for growth in the transportation capacity needed for some tasks. An example is the growth of petroleum, oils, and lubricants, and ammunition requirements due to the XM1 tank and IFV/CFV.